

U.S. DEPARTMENT OF COMMERCE, PATENT AND TRADEMARK OFFICE		DATE: <b>June 11, 2001</b>
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		U.S. APPL. NO. (if known) <b>09/856489</b>
INTERNATIONAL APPLICATION NO.: <b>PCT/ IB 99 /01945</b>	INTERNATIONAL FILING DATE: <b>December 6, 1999</b>	PRIORITY DATE CLAIMED: <b>December 11, 1998</b>
TITLE OF INVENTION: <b>CRUSHER</b>		
APPLICANT(S) FOR DO/EO/US: <b>Nils KONG-MARK, Harald WIRTH and Klaus ROEHRICH</b>		
Applicant hereby submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:		
<p>1. <u>XX</u> This is a <b>FIRST</b> submission of items concerning a filing under 35 U.S.C. 371.</p> <p>2. <u>  </u> This is a <b>SECOND</b> or <b>SUBSEQUENT</b> submission of items concerning a filing under 35 U.S.C. 371.</p> <p>3. <u>XX</u> This express request to begin national examination procedures (35 USC 371(f)) at any time rather than delay examination until the expiration of the time limit set in 35 USC 371(b) and PCT Articles 22 and 39(1).</p> <p>4. <u>XX</u> A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.</p> <p>5. <u>XX</u> A copy of the International Application as filed (35 U.S.C. 371(c)(2)):</p> <p style="margin-left: 40px;">a. <u>  </u> is transmitted herewith (required only if not transmitted by the International Bureau).</p> <p style="margin-left: 40px;">b. <u>XX</u> has been transmitted by the International Bureau.</p> <p style="margin-left: 40px;">c. <u>  </u> is not required, as the application was filed in the United States Receiving Office (RO/US).</p> <p>6. <u>XX</u> A translation of the International Application into English (35 U.S.C. 371(c)(2)).</p> <p>7. <u>XX</u> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))</p> <p style="margin-left: 40px;">a. <u>  </u> are transmitted herewith (required only if not transmitted by the International Bureau).</p> <p style="margin-left: 40px;">b. <u>  </u> have been transmitted by the International Bureau.</p> <p style="margin-left: 40px;">c. <u>  </u> have not been made; however, the time limit for making such amendments has NOT expired.</p> <p style="margin-left: 40px;">d. <u>XX</u> have not been made and will not be made.</p> <p>8. <u>  </u> A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).</p> <p>9. <u>  </u> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).</p> <p>10. <u>XX</u> A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).</p>		
<b>ITEMS 11. TO 16. BELOW CONCERN OTHER DOCUMENT(S) OR INFORMATION INCLUDED:</b>		
<p>11. <u>XX</u> An Information Disclosure Statement under 37 CFR 1.97 and 1.98 together with the <u>International Search Report</u> and 7 references</p> <p>12. <u>  </u> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.  ASSIGNEE NAME AND ADDRESS: <b>RIMM TECHNOLOGIES N.V.,</b>  <b>Curacao, Netherland Antilles</b>  <b>Please publish the assignee data with the application.</b></p> <p>13. <u>XX</u> A <b>FIRST</b> preliminary amendment.  <u>  </u> A <b>SECOND</b> or <b>SUBSEQUENT</b> preliminary amendment</p> <p>14. <u>  </u> A substitute specification.</p> <p>15. <u>  </u> A change of power of attorney and/or address letter.</p> <p>16. <u>  </u> Other items or information:</p>		

*(The following information was obtained from the records of the Department of Social Services, New York City.)*

U.S. APPLICATION NO. (if known) <b>09/856489</b>	INTERNATIONAL APPLICATION NO. <b>PCT/IB 99/01945</b>	DATE: <b>June 11, 2001</b> <b>531 Rec'd PCT/IB 11 JUN 2001</b>
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a. ☒ A check in the amount of **\$990.00** to cover the above fees is enclosed. (\$860.00 for filing fee and \$130.00 for late filing of Declaration)


b. ☐ Please charge my Deposit Account No. 01-2340 in the amount of \$\_\_\_ to cover the above fees. (A duplicate copy of this sheet is enclosed.)

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 01-2340.

**NOTE:** Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed to request that the application be restored to pending status.

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**Atty Docket: 010679**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of:

Nils KONG-MARK et al.

Serial Number: Not Yet Assigned  
(National Stage of PCT/IB99/01945)

Group Art Unit: Not Yet Assigned

Filed: Herewith

Examiner: Not Yet Assigned

For: CRUSHER

**PRELIMINARY AMENDMENT**

Honorable Commissioner of Patents  
Washington, D.C. 20231

Sir:

Prior to examination of the present application, please amend as follows.

A marked-up version of the amendments is included in this response.

AMENDMENTS

IN THE CLAIMS:

Please amend claims 1-15 as follows.

1. (Amended) Blade crusher, comprising means which combines a crushing action with a double shearing action in two orthogonal spatial planes.

2. (Amended) Crusher according to Claim 1, wherein the orthogonal planes are vertical and horizontal planes.

3. (Amended) Crusher according to Claim 1, wherein the means which combines a crushing action with a double shearing action in two orthogonal planes comprises at least two successive pairs of movable toothed blades forming jaws, each pair consisting of two opposite corresponding toothed blades driven in a reciprocating motion moving them apart and bringing them together so as to abut against one another when the teeth engage in one another, at least part of the teeth of the blades possessing a face oriented perpendicularly to the plane of the reciprocating motion of the blades, and the second pair of blades sliding against the first pair of blades so as to come into abutment in a position offset with respect to the abutment position of the first pair of toothed blades.

4. (Amended) Crusher according to Claim 2, wherein the blades constituting the pairs of blades are in a vertical position and have teeth possessing, at least in part, horizontal surfaces oriented respectively upwards and downwards, so that the double shearing action is due to a

vertical shearing action produced by the crossing of the successive blades sliding against one another, combined with a horizontal shearing action produced by the crossing of the faces of the teeth oriented respectively upwards and downwards, sliding against one another.

5. (Amended) Crusher according to Claim 4, wherein the blades extend upwards by way of upper zones, which are likewise toothed, but which do not engage in one another, adopting in contrast a V-shaped geometric position forming a hopper when the toothed blades are engaged in one another in the lower abutment zone.

6. (Amended) Crusher according to Claim 4, wherein, in the abutment zone, the toothed blades constituting the pairs are oblique.

7. (Amended) Crusher according to Claim 4, wherein, in the abutment zone, the toothed blades constituting the pairs possess a curved, for example S-shaped, profile.

8. (Amended) Crusher according to Claim 1, wherein fixed blades are interposed between the movable blades.

9. (Amended) Crusher according to Claim 4, which comprises in the lower part a cutout forming a free space in which the teeth of the opposite blade do not come into abutment.

10. (Amended) Crusher according to Claim 4, which comprises in the lower part and at the extremity another cutout which cooperates with a nose or nib projecting concordantly on the opposite blade.

11. (Amended) Crusher according to Claim 1, wherein the blades are brought together and moved apart on a linear path situated in the same plane, or in two planes forming between them an obtuse angle other than  $180^\circ$ , the converging motion in this case being oblique.

12. (Amended) Crusher according to Claim 1, wherein the blades are brought together and moved apart on a curvilinear or arcuate path.

13. (Amended) Crusher according to Claim 1, which is in modular form, it being possible to add pairs of toothed blades alongside existing blades to increase the crushing capacity, or remove them to reduce the capacity, weight and space taken up.

14. (Amended) Multi-stage crushing assembly, comprising a plurality of crushers according to Claim 1 installed in series, wherein the crushed material obtained by one crusher feeds the following crusher of the series.

15. (Amended) Medical waste-sterilising installation, which comprises, as a unit placed upstream of a microwave sterilising apparatus, a crusher according to Claim 1 or a crushing assembly according to Claim 14.

Please add new claims 16-18 as follows.

16. (New) Crusher according to claim 5 wherein, in the abutment zone, the toothed blades constituting the pairs are oblique.

17. (New) Crusher according to claim 5, wherein, in the abutment zone, the toothed blades constituting the pairs possess a curved, for example S-shaped, profile.

Serial Number: Not Yet Assigned  
(National Stage of PCT/IB99/01945)

Group Art Unit: Not Yet Assigned

18. (New) Crusher according to claim 6, wherein, in the abutment zone, the toothed blades constituting the pairs possess a curved, for example S-shaped, profile.



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(National Stage of PCT/IB99/01945)

Group Art Unit: Not Yet Assigned

MARKED-UP VERSION OF AMENDMENTS

Claims 1-15 have been amended as follows.

1. (Amended) Blade crusher, [characterised by an operation] comprising means which combines a crushing action with a double shearing action in two orthogonal spatial planes.

2. (Amended) Crusher according to Claim 1, [characterised in that] wherein the orthogonal planes are vertical and horizontal planes.

3. (Amended) Crusher according to Claim 1, [characterised in that it] wherein the means which combines a crushing action with a double shearing action in two orthogonal planes comprises at least two successive pairs of movable toothed blades forming jaws, each pair consisting of two opposite corresponding toothed blades [(1,2)] driven in a reciprocating motion moving them apart [(f2)] and bringing them together [(f1)] so as to abut against one another when the teeth engage in one another, at least part of the teeth of the blades [(1,2)] possessing a face oriented perpendicularly to the plane of the reciprocating motion of the blades, and the second pair of blades sliding against the first pair of blades so as to come into abutment in a position offset with respect to the abutment position of the first pair of toothed blades.

4. (Amended) Crusher according to Claim 2, [characterised in that] wherein the blades [(1, 2)] constituting the pairs of blades are in a vertical position and have teeth [(11)] possessing, at least in part, horizontal surfaces oriented respectively upwards [(15)] and downwards [(14)], so that the double shearing action is due to a vertical shearing action produced by the crossing of

the successive blades sliding against one another, combined with a horizontal shearing action produced by the crossing of the faces of the teeth oriented respectively upwards [(15)] and downwards [(14)], sliding against one another.

5. (Amended) Crusher according to Claim 4, [characterised in that] wherein the blades extend upwards by way of upper zones [(7 and 9 respectively)], which are likewise toothed, but which do not engage in one another, adopting in contrast a V-shaped geometric position forming a hopper when the toothed blades are engaged in one another in the lower abutment zone [(8 and 10 respectively)].

6. (Amended) Crusher according to Claim 4 [or 5, characterised in that], wherein, in the abutment zone [(8 and 10 respectively)], the toothed blades [(1,2)] constituting the pairs are oblique.

7. (Amended) Crusher according to Claim 4, [5 or 6, characterised in that] wherein, in the abutment zone [(8 and 10 respectively)], the toothed blades [(1,2)] constituting the pairs possess a curved, for example S-shaped, profile.

8. (Amended) Crusher according to [one of the preceding claims, characterised in that] Claim 1, wherein fixed blades are interposed between the movable blades.

9. (Amended) Crusher according to [one of Claims 4 to 8, characterised in that it] Claim 4, which comprises in the lower part a cutout [(17)] forming a free space [(18)] in which the teeth of the opposite blade do not come into abutment.

10. (Amended) Crusher according to [one of Claims 4 to 9, characterised in that it] Claim 4, which comprises in the lower part and at the extremity another cutout [(20)] which cooperates with a nose or nib [(19)] projecting concordantly on the opposite blade.

11. (Amended) Crusher according to [one of the preceding claims, characterised in that] Claim 1, wherein the blades are brought together and moved apart on a linear path situated in the same plane, or in two planes forming between them an obtuse angle other than  $180^\circ$ , the converging motion in this case being oblique.

12. (Amended) Crusher according to [one of the preceding claims, characterised in that] Claim 1, wherein the blades are brought together and moved apart on a curvilinear or arcuate path.

13. (Amended) Crusher according to [one of the preceding claims, characterised in that it] Claim 1, which is in modular form, it being possible to add pairs of toothed blades alongside existing blades to increase the crushing capacity, or remove them to reduce the capacity, weight and space taken up.

14. (Amended) Multi-stage crushing assembly, comprising a plurality of crushers according to [one of the preceding claims] Claim 1 installed in series, [characterised in that] wherein the crushed material obtained by one crusher feeds the following crusher of the series.

15. (Amended) Medical waste-sterilising installation, [characterised in that it] which comprises, as a unit placed upstream of a microwave sterilising apparatus, a crusher according to [any one of the preceding claims] Claim 1 or a crushing assembly according to Claim 14.

Serial Number: Not Yet Assigned  
(National Stage of PCT/IB99/01945)

Group Art Unit: Not Yet Assigned

New claims 16-18 have been added.

Serial Number: Not Yet Assigned  
(National Stage of PCT/IB99/01945)

Group Art Unit: Not Yet Assigned

REMARKS

By the present amendment, claims 1 and 3 have been amended to incorporate changes made during the international stage. Further, claims 1-15 have been amended to replace "characterised in that" by "wherein" or "which," to delete reference numbers, and to modify dependencies. New claims 16-18 corresponding to claims 6 and 7, respectively, but dependent on claims 5 and 6, respectively, have been added.

Early and favorable examination of the present application is respectfully requested.

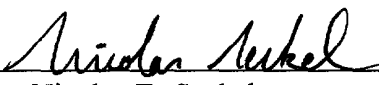
Serial Number: Not Yet Assigned  
(National Stage of PCT/IB99/01945)

Group Art Unit: Not Yet Assigned

In the event this paper is not considered to be timely filed, the Applicants hereby petition for an appropriate extension of the response period. Please charge the fee for such extension and any other fees which may be required to our Deposit Account No. 01-2340.

Respectfully submitted,

ARMSTRONG, WESTERMAN, HATTORI,  
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NES:rep

AMENDED CLAIMS

1. Blade crusher, characterised in that it comprises means which combines a crushing action with a double shearing action in two orthogonal spatial planes.
- 5 2. Unchanged
3. Crusher according to claim 1, characterised in that the means which combines a crushing action with a double shearing action in two orthogonal spatial planes comprises at least two successive pairs of movable toothed blades forming jaws, each pair consisting of two opposite corresponding toothed blades (1,2) driven in  
10 a reciprocating motion moving them apart (f2) and bringing them together (f1) so as to abut against one another when the teeth engage in one another, at least part of the teeth of the blades (1,2) possessing a face oriented perpendicularly to the plane of the reciprocating motion of the blades, and the second pair of blades sliding against the first pair of blades so as to come into abutment in a position offset with respect to the  
15 abutment position of the first pair of toothed blades.
4. Unchanged
5. Unchanged
6. Unchanged
7. Unchanged
- 20 8. Unchanged
9. Unchanged
10. Unchanged
11. Unchanged
12. Unchanged
- 25 13. Unchanged
14. Unchanged
15. Unchanged

09/856489-091701

CRUSHER

The invention relates to a crusher or breaker for bulk material in a heterogeneous mixture, enabling the reduction of this material to particles of small sizes so as to reduce the volume thereof as far as possible. Its operation employs a system of toothed blades in relative linear motion, combining simultaneously shearing functions with breaking functions. If the material in question is essentially organic and non-infectious, it will be possible to use the crushed material obtained as compost, whereas if the opposite is the case, it will be possible to dump it directly. Sorting or other processing thereof, such as decontamination or sterilisation, will thereby be facilitated.

For a long time there has been a need to crush used materials, and numerous methods and devices have been developed for the crushing of such materials, enabling the crushing, cutting, chopping, tearing to pieces, dilaceration, etc. thereof.

In reality, only a small number of methods are in current use. They employ knives or shears, such as paper crushers, rotary-blade crushers, for the destruction of metals, plastics and rubber, or else jaw crushers (stone or rock materials). Each of these methods has often prohibitive disadvantages when they are used outside their strict applications, for example for processing heterogeneous mixtures of diverse materials.

Nowadays, the increase in the costs of transporting and storing waste makes it necessary to crush the materials at a location as close as possible to the place where they are produced. There is thus a great and ever-increasing demand for a used-material crusher which takes up little space, is lightweight and is usable, for example, in a workshop or laboratory, and even simply as a domestic appliance. This type of apparatus must have low consumption, make little noise and be able to process various materials of greatly varying thicknesses. As already indicated, the known solutions mentioned above have



little to offer in this regard. Paper crushers are not strong enough to process plastic and metals, even of low thickness. Crushers of larger dimensions generally operate with the aid of rotary blades which generate a noise which  
5 necessitates protection in order to be able to stay in the vicinity. The problem of the crushing of fabrics and quarry waste also remains. Crushers or breakers used in quarries, apart from the enormous noise which they too generate, are of dimensions which are too large, consume enormous amounts  
10 of power, and produce excess fines and dust.

As a matter of interest, mention will be made of crushers of the type having balls or hammers, used in laboratories or in industry for reducing hard materials to fine powders, but these instruments generate intolerable  
15 noise and in any case are not designed for processing materials consisting of heterogeneous mixtures.

In contrast, the invention solves the above-mentioned problems, namely to obtain a particulate product which can be easily handled, processed further if necessary,  
20 transported and stored.

The crusher according to the invention enables the reduction to particles of heterogeneous materials, both organic and mineral or mixed: it is of small dimensions, is quiet and consumes little power, merely using a  
25 conventional electrical connection, as can be found in a simple residence. Furthermore, it will be seen that it is self-cleaning and that its actual design enables very easy maintenance.

A feature of the crusher is that its operation  
30 combines a crushing action which cooperates with a double shearing action in two orthogonal spatial planes.

Preferably, the orthogonal planes are vertical and horizontal planes.

According to one embodiment, the crusher comprises at  
35 least two successive pairs of movable toothed blades forming jaws, each pair consisting of two opposite corresponding toothed blades driven in a reciprocating

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In the crushing zone, the toothed blades constituting the pairs are advantageously arranged obliquely.

The pairs of blades may be driven with respect to one another in a synchronous or an asynchronous motion, and  
5 between the movable blades may be interposed blades which are fixed or have a different stroke.

The blades may be brought together and moved apart on a linear path situated on a congruent axis, in the same plane, or in two planes forming between them an obtuse  
10 angle other than  $180^\circ$ , for example up to  $120^\circ$ . The converging motion in this case is oblique, preferably downwards in order to further intensify the self-feeding phenomenon of the waste.

It should also be noted that this reciprocating  
15 motion, whatever the planes, may also be curvilinear or arcuate, here too oriented downwards when the blades are brought together. Such a result is easily obtained by offsetting the axis on which the blades are fixed, with respect to the point at which the actual reciprocating  
20 motion is applied to them. This generates a swinging motion, downwards if the point at which the blades are fixed is at the bottom.

Owing to its actual design, such a crusher may be in modular form, it being possible to add pairs of toothed  
25 blades alongside existing blades to increase the crushing capacity, or remove them to reduce the capacity, weight and space taken up. This is obviously a great advantage compared with traditional crushers, in particular compared with worm crushers, which are naturally fixed in their  
30 dimensions and capacities.

Of course, apart from the above elements which constitute the actual invention, the crusher also comprises mechanical parts necessary for its operation, that is to say one or more motors powered electrically or  
35 pneumatically or else hydraulically, the necessary frames or supports, the feed hoppers and the members for discharging and recovering the crushed materials produced.

Also, of course, the blades are made of a material which is strong enough to cut and crush, while retaining a residual elasticity to allow for the shearing forces. The material chosen for the blades or their coating, as well as the shape and design of the teeth and mechanical interfaces, depends on the chosen applications. Mention will be made of steel, carbides or nitrides, certain ceramics obtained by sintering in particular, in solid or plated form.

It should be understood that when "abutment" is referred to, this does not necessarily mean that the teeth come directly into contact face against face: the abutment motion may leave a slight space remaining between these two blades, which is precisely of the order of magnitude of the sizes of the particles of crushed materials obtained. In addition, to allow a mechanical tolerance, the teeth in the abutment zone may possess a slight cutout at the end or chamfer.

Although the crusher according to the invention requires at least one pair of blades to function, it is obvious that, in practice, the number of blades will be much higher, typically from a few tens to a few hundreds, without this number necessarily being even. Everything will obviously depend on the crushing capacity required and on the general dimensional constraints.

The width of the blades also depends on the sizes of the particles of the crushed material, as well as on the maximum sizes of the materials to be crushed, the number of blades placed side by side defining the maximum length of the material accepted.

The invention will be better understood with reference to the attached drawings, given by way of non-limiting example. In these drawings:

- Figure 1 is a side view of the pair of cooperating blades driven in a reciprocating motion bringing them together and moving them apart;

- Figure 2a is a view of a pair of identical blades, shown in perspective, but the upper part of which is funnel-shaped;

- Figure 2b is a perspective view corresponding to Figure 2a, in which several pairs of blades are arranged side by side;

- Figure 3 is a plan view of the basic arrangement explaining the interpenetration of the blades and the shearing actions; and

- Figure 4 is a view similar to that of Figure 1 and relates to another embodiment.

As can be seen in Figure 1, the pair of blades comprises a blade 1 or "male" blade, and a blade 2 or "female" blade cooperating with the blade 1. Each of these blades comprises perforations 3,4 serving respectively to fix them on supporting and driving shafts (not shown), 5,6 respectively, the aim of which is above all to lighten the weight of the assembly. The male blade 1 comprises an upper entry zone 7 which serves to compact, pre-crush, possibly pre-grind and pre-tear, the material brought into this zone, and a lower zone 8, where the crushing and final grinding is carried out. The female blade 2 likewise comprises an upper zone 9 and a lower grinding zone 10, the teeth of which interpenetrate and cooperate with the teeth of the zone 8. The two upper zones 7,9 of the blades together form a V-shaped hopper, the role of which is to advance the material held in this hopper downwards.

In the lower zone, the male blade 1 projects, whereas the corresponding part of the female blade 2 is S-shaped, so as to define a passage for the crushed material and avoid the possibility of pieces passing through the blades without being processed.

These teeth are designated by the reference numerals 11,12 on each of the two blades, male 1 and female 2 respectively. In their upper zones 7,9, the blades 11 have teeth which possess a horizontal face 13 directed upwards. Given that the other face 13' of these same teeth 11 is

inclined downwards, the moving apart and then the bringing together of the blades pushes the material downwards, as indicated above, creating a self-feeding action.

In the lower zones of the blades, which are  
 5 advantageously inclined with respect to the vertical (by an angle  $\alpha$  of about  $45^\circ$  in the figures, but which may for example be between  $0$  and  $60^\circ$ , values which may vary enormously depending on the applications), the teeth possess respectively a horizontal face oriented downwards  
 10 14 and a horizontal face oriented upwards 15.

Although not shown in Figure 1, for the sake of simplicity, the blades possess a slight cutout at the end in order to facilitate their fitting together, while allowing a mechanical tolerance in the mounting of the  
 15 systems of blades. However, such a cutout or chamfer is shown on a blade of Figure 4, reference 16.

Finally, between the upper zones 7 or 9 and lower zones 8 or 10 of each blade 1 or 2, there is a connecting zone comprising more conventional teeth 12 with inclined  
 20 faces, these faces being complementary so as to fit together.

These blades are driven in a reciprocating motion bringing them together in accordance with f1 or moving them apart in accordance with f2. When they are brought together  
 25 f1, all the teeth of the intermediate connecting zones and of the lower zones fit together, the faces 14 and 15 of the teeth in correspondence sliding against one another while exerting a horizontal shearing action.

It should be noted that with the words "horizontal" and "vertical", the point of reference is the axis of the  
 30 crusher as a whole, as it is normally installed, placed or fixed on the ground. It may be inclined, without this in any way changing the crushing and shearing actions.

In Figure 1, the upper zones of the two blades form a  
 35 figure in the shape of an upright V, forming a feed hopper, with a half opening angle of the order of  $45^\circ$  with respect to the vertical. This angle  $\beta$ , which may be identical to or

different from the angle  $\alpha$  mentioned above, may also vary between  $0^\circ$  and  $60^\circ$ , and the V may possess a profile which is curvilinear or in successive sections of different inclination. This part thus forms a funnel for the material  
 5 to be crushed and the shape of the teeth present in the funnel helps to move the material downwards towards the lower grinding zone, as has already been indicated and is clearly apparent in Figure 2a.

In this Figure 2a, which is merely a simplified  
 10 diagram showing only a single pair of blades, the movement of the material downwards is illustrated by the arrow f3. It will be observed that here the funnel has a shape which is not straight but curves progressively.

In Figure 2b, which corresponds to Figure 2a, the  
 15 crusher according to the invention is equipped with five consecutive pairs of blades (101,201;102,202;103,203; 104,204;105,205), some of which (201,102,203,104,205) are fixed.

To be more specific, when it is desired to obtain a  
 20 crusher with a particle size of the crushed materials obtained of the order of 5 mm, the following will be chosen: a blade thickness of the same order of magnitude (for example 3 to 5 mm), a height for the lower teeth of from about 5 to 10 mm, and a height of the blades in the  
 25 lower zone of 6 to 8 cm, for a total height of the blades which may reach 20 cm; sixty blades, for example, will be arranged side by side for a width of 30 cm.

The value of 5 mm is merely an example, since by  
 varying the above parameters, it is possible to choose the  
 30 particle sizes of the crushed materials.

In this Figure 2b, the blade 101 is female and the blade 201 is male, the blade 102 is male and the blade 202 is female and so on alternately, the zones 1 and 9, and 8 and 10, respectively, alternating correlatively on each of  
 35 the two sides.

The crusher operates in the following manner, it being understood that the motion of the blades may be

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synchronised, or else offset in space or time. For greater simplicity and better comprehension, the synchronised operating mode will be explained hereinbelow in more detail. The blades move in a way that they are brought  
 5 together and moved apart and the material placed in the hopper-forming "funnel" is, as far as the coarse pieces are concerned, already torn and pierced, so that first of all a compacting and partial crushing action takes place. By virtue of the shape of the teeth, the material is pushed  
 10 downwards where it is compacted more and more.

There then begins a vertical shearing action as a result of the two consecutive blades sliding on one another (101 against 202; 202 against 103; 103 against 204, etc.). The material then enters the connecting zone, and then the  
 15 lower zone of the blades (8,10) where it is crushed, ground, broken, cut and sheared, in short cut up and reduced to small particles. There is always a vertical shearing action between two consecutive blades, but there is then added to this a horizontal shearing action between  
 20 the complementary faces, oriented respectively upwards (15) and downwards (14), of the teeth of the two opposite blades being brought together. To this double shearing action is also added a crushing action between these same two blades being brought together, forming jaws or pincers.

It will be noted that, between Figure 1 and Figure 2a or 2b, the faces of the teeth (14,15) of the blades in their lower zone have been reversed on the male and female blades. This is done to show clearly that the relative arrangement of these faces is immaterial, provided that  
 30 they are horizontal.

The shearing action between two consecutive blades sliding against one another is a vertical shearing action which cuts the material, whereas the shearing action between two horizontal tooth faces in the grinding zone is  
 35 a horizontal shearing action which likewise cuts the material. The crushing action is obtained by the blades

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which are brought together so as to bear against one another in the lower zone 8.

The angle parameters of the funnel and its shape, and the geometry and length of the lower grinding zone are  
 5 determined to enable preliminary piercing, tearing or compressing of the material in the funnel, and to enable it to be pushed into the grinding zone where it is ground when the teeth engage in one another until they are in abutment, with the clearance governed by the final size of the  
 10 particles of crushed material.

Furthermore, the blades may be mounted on an elastic device (springs or dampers) with play, so that they only come completely into abutment, face against face, when there is no particle of crushed material held between them,  
 15 allowing the clearance which is necessary if the opposite is the case.

Figure 3 is a plan view of the blades in a variant in which the crusher comprises alternately fixed blades (102,201,103,204,etc.), represented by shading, whereas the  
 20 movable blades (101,202,103,204,etc.) are represented with hatching. The letters a, b, c and d represent different stages of the moving apart and bringing together of the movable blades. At a, all the blades are separated. At b, the movable blades have passed the fixed blades and have  
 25 thus removed any material which may have become attached to them (cleaning stage). At c, the movable blades have just passed one another and the material has been cut by shearing on the vertical edges. At d, the movable blades penetrate into the fixed blades and the material is sheared  
 30 horizontally by the horizontal tooth faces sliding on one another, and then crushed and ground at the end of the stroke. At this point, the movable blades are moved apart, and position a is assumed again.

It will be observed here that the friction generated  
 35 when the blades are moved apart frees the material or the particles held between them, which fall downwards to be taken up by the teeth situated below. This geometry means

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that the crusher according to the invention is "anti-blocking", that is to say that no particle of crushed material can accumulate over a long time until it blocks the operation of the blades.

5 It will also be noted, in relation to the foregoing, that the crusher is "self-cleaning" as well, the blades being arranged such that, during their travel, the vertical edge of a blade passes against the vertical edge of its neighbours. By moving forwards, a blade pushes back the  
10 material which may adhere to a tooth of its neighbours. The cut pieces fall further down to be subjected to a new crushing and shearing action.

In Figure 4, which illustrates another embodiment, the male blade 1 and female blade 2 have been crossed over from  
15 left to right, so as to show clearly that the arrangement of these blades, from right to left or from left to right, is immaterial. All the elements already described in Figure 1 are found again, with the same reference numerals.

The differences lie in the following elements. First  
20 of all, the general S shape is less marked, or even absent. The surfaces 13 and 13' of the teeth 11 in the upper zones 7 and 9 are oblique and the passages 4 and 6 are joined. It should be noted that a chamfer 16 is shown on one of the blades, but in reality, all the blades which are to slide  
25 on one another possess such a chamfer. These chamfers are aimed at improving the guidance during the interpenetration.

The essential difference lies in the lower part of the blades, since the female blade 2 possesses, from bottom to  
30 top, a cutout 17 without teeth and with a substantially curvilinear geometry 17. According to a variant embodiment, there follows at the extremity a second cutout 20 forming a clearance. The female blade 1 in this case possesses, at the end, a projection 10 in the form of a nib or nose which  
35 will take up a position in the above cutout 20.

Between the cutout 17 and the teeth of the opposite blade is formed a free space 18 in which the materials

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being dilacerated reside temporarily, before being expelled therefrom as a result of the cooperation between the nose 19 and the cutout 20.

The cutout 20 may be carried by the same blade as the cutout 17, or by the opposite blade.

It has been found that this embodiment further improves the expulsion of the crushed materials, avoiding a situation where certain filiform dilacerated materials remain jammed between the consecutive blades. It should be born in mind that the two blades being brought together and moved apart are preceded and followed by other pairs of blades being brought together and moved apart, or, as indicated hereinabove, alternately fixed blades, so that the space 18 is in reality a three-dimensional chamber.

The blades are actuated by the shafts which pass through them (see Figures 1 and 4). It should be noted here that, depending on the weight of the blades constituting the jaws and the material constituting the teeth, the driving motion must be sufficient. However, once the motion is initiated, with the blades being advantageously accelerated over a length of about 30 mm in about one second, the material is cut not only by the force imparted to the blades by the driving motion, but also by the stored kinetic energy. For example, 60 pairs of blades with a thickness of 5 mm as shown in Figure 1, actuated by 4 jacks with a diameter of 25 mm powered by a hydraulic unit with a 0.75 kW motor, provide a torque of greater than 1 tonne.

Owing to its remarkable efficiency due to the triple action, shearing in two planes and crushing, the crusher according to the invention may be of small dimensions and of low weight and thus have wide application in fields where it is necessary to have a crusher which is lightweight and consumes little power, for reducing heterogeneous materials, such as waste, to particles as small as possible and for reducing the volume thereof.

Such a crusher will thus be advantageously usable in small workshops or laboratories or in the home, as well as

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on board aircraft where weight and bulk pose major problems and where in general only metered electricity generation is available.

Furthermore, this crusher may constitute one of the  
5 elements of a multi-stage crushing assembly, comprising a plurality (n) of crushers according to the invention installed in series. The crushed material obtained by one crusher (n-1) feeds the following crusher (n) in the series.

10 The crusher or crushing assembly will also be of special interest in the hospital environment. The reason for this is that hospital waste is in general a mixture of human tissues, diverse textile materials (compresses, etc.), rubber materials (surgical gloves, etc.), syringes  
15 (mixture of plastic and metal), and even paper and cardboard (packaging). Because human tissues are liable to be infectious, hospital waste must not be fed into the traditional system. On the contrary, it must be processed separately, either in ad hoc plants outside the hospital,  
20 or in a treatment centre inside the hospital. These are always huge, noisy installations with a very high power consumption, with which are associated sterilising installations for destroying all the pathogenic germs. In all cases, the waste must be transported outside the  
25 operating theatre.

Recently, medical processing apparatuses using microwave sterilisation have been developed, comprising a crusher for the pre-processing of the waste, of sufficiently modest dimensions so that each operating  
30 theatre or each department can have its own apparatus, thereby avoiding any transportation and outside handling. Such a microwave processing apparatus is described for example in WO 97/44069.

In order for the apparatus in question to retain a  
35 bulk compatible with the operating theatre, it is necessary for the hospital waste which is to be processed, of a heterogeneous nature, to undergo preliminary crushing to

small sizes and this is precisely where the crusher according to the invention comes in, as an independent machine, or preferably in a combined installation for crushing and sterilising, in particular sterilising using  
5 microwaves.

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CLAIMS

1. Blade crusher, characterised by an operation which combines a crushing action with a double shearing action in two orthogonal spatial planes.

2. Crusher according to Claim 1, characterised in that the orthogonal planes are vertical and horizontal planes.

3. Crusher according to Claim 1, characterised in that it comprises at least two successive pairs of movable toothed blades forming jaws, each pair consisting of two opposite corresponding toothed blades (1,2) driven in a reciprocating motion moving them apart (f2) and bringing them together (f1) so as to abut against one another when the teeth engage in one another, at least part of the teeth of the blades (1,2) possessing a face oriented perpendicularly to the plane of the reciprocating motion of the blades, and the second pair of blades sliding against the first pair of blades so as to come into abutment in a position offset with respect to the abutment position of the first pair of toothed blades.

4. Crusher according to Claim 2, characterised in that the blades (1,2) constituting the pairs of blades are in a vertical position and have teeth (11) possessing, at least in part, horizontal surfaces oriented respectively upwards (15) and downwards (14), so that the double shearing action is due to a vertical shearing action produced by the crossing of the successive blades sliding against one another, combined with a horizontal shearing action produced by the crossing of the faces of the teeth oriented respectively upwards (15) and downwards (14), sliding against one another.

5. Crusher according to Claim 4, characterised in that the blades extend upwards by way of upper zones (7 and 9

respectively), which are likewise toothed, but which do not engage in one another, adopting in contrast a V-shaped geometric position forming a hopper when the toothed blades are engaged in one another in the lower abutment zone (8 and 10 respectively).

6. Crusher according to Claim 4 or 5, characterised in that, in the abutment zone (8 and 10 respectively), the toothed blades (1,2) constituting the pairs are oblique.

7. Crusher according to Claim 4, 5 or 6, characterised in that, in the abutment zone (8 and 10 respectively), the toothed blades (1,2) constituting the pairs possess a curved, for example S-shaped, profile.

8. Crusher according to one of the preceding claims, characterised in that fixed blades are interposed between the movable blades.

9. Crusher according to one of Claims 4 to 8, characterised in that it comprises in the lower part a cutout (17) forming a free space (18) in which the teeth of the opposite blade do not come into abutment.

10. Crusher according to one of Claims 4 to 9, characterised in that it comprises in the lower part and at the extremity another cutout (20) which cooperates with a nose or nib (19) projecting concordantly on the opposite blade.

11. Crusher according to one of the preceding claims, characterised in that the blades are brought together and moved apart on a linear path situated in the same plane, or in two planes forming between them an obtuse angle other than  $180^\circ$ , the converging motion in this case being oblique.

12. Crusher according to one of the preceding claims, characterised in that the blades are brought together and moved apart on a curvilinear or arcuate path.

5 13. Crusher according to one of the preceding claims, characterised in that it is in modular form, it being possible to add pairs of toothed blades alongside existing blades to increase the crushing capacity, or remove them to reduce the capacity, weight and space taken up.

10

14. Multi-stage crushing assembly, comprising a plurality of crushers according to one of the preceding claims installed in series, characterised in that the crushed material obtained by one crusher feeds the following  
15 crusher of the series.

15. Medical waste-sterilising installation, characterised in that it comprises, as a unit placed upstream of a microwave sterilising apparatus, a crusher according to any  
20 one of the preceding claims or a crushing assembly according to Claim 14.

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**Declaration for U.S. Patent Application**

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention **entitled**

CRUSHER the specification of which is attached hereto unless the following is checked

5 was filed on December 6, 1999 as United States Application Number or PCT International Application Number PCT/IB99/01945 and was amended on February 6, 2001 (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, ' 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, ' 119 (a) - (d) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application for which priority is claimed:

				Priority Claimed
(List prior foreign applications.	<u>98420231.7</u>	<u>EPO</u>	<u>11/12/1998</u>	<u>XX</u> Yes ___ No
See note A on back of this page)	(Number)	(Country)	(Day/Month/Year Filed)	___ Yes ___ No
	(Number)	(Country)	(Day/Month/Year Filed)	___ Yes ___ No
	(Number)	(Country)	(Day/Month/Year Filed)	___ Yes ___ No
	(Number)	(Country)	(Day/Month/Year Filed)	___ Yes ___ No

(See note B on back of this page)

\_\_\_ See attached list for additional prior foreign applications

I hereby claim the benefit under Title 35, United States Code, ' 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, ' 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, ' 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

(List Prior U.S. Applications)	(Appln. Serial No.)	(Filing Date)	(Status: Patented, Pending, Abandoned)
	(Appln. Serial No.)	(Filing Date)	(Status: Patented, Pending, Abandoned)
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I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Title 18 of the United States Code, ' 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

(See note C  
above)

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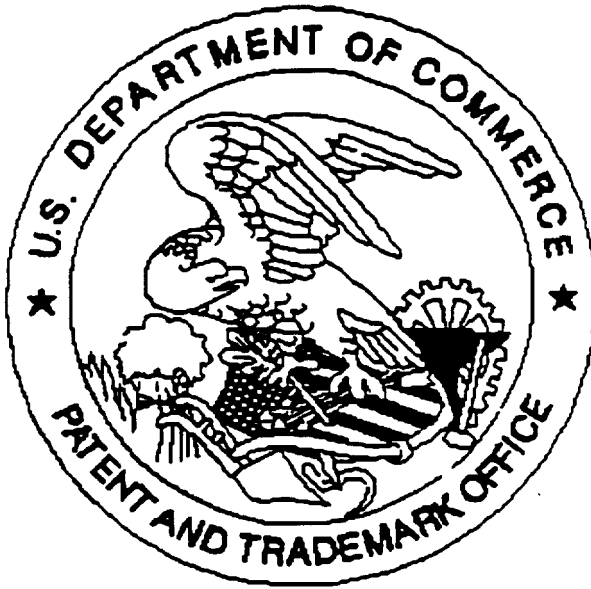
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